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# Laboratory efficacy of different insecticides against maize fall armyworm, *Spodoptera frugiperda* (J. E. Smith)

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**Abstract**
Study on laboratory efficacy of different insecticides against *Spodoptera frugiperda* (J. E. Smith) were carried out at Biocontrol Research Laboratory, Department of Entomology, Junagadh Agricultural University, Junagadh. The result showed that the treatments of spinetoram 11.7 EC, 0.012%, emamectin benzoate 5 SG, 0.0025% and thiodicarb 75 WP, 0.075% were found the most effective against *S. frugiperda* as they recorded cent per cent mortality after 5 days of treatment under laboratory condition. However, it was followed by chlorantraniliprole 18.5 SC, 0.005%, spinosad 45 SC, 0.013% and chlorantraniliprole 9.3% +lambda-cyhalothrin 4.6% ZC, 0.006% in which mortality of 85.56, 81.11 and 70.00% was recorded after 5 days, respectively.

**Keywords:** Laboratory, maize fall armyworm, *Spodoptera frugiperda*

## Introduction
Maize (*Zea mays* L.) is the third most important grain crop in the world, which is widely cultivated all over the world in different agro-climatic zones. Worldwide, it is popularly known as the "Queen of cereals" due to its wider adaptability and highest genetic yield potential among cereal crops. Maize is a storehouse of various nutrients such as carbohydrates, proteins, minerals, vitamins, iron, etc. and particularly supplies high energy of 365 Cal/100 g. It serves many purposes such as the source of human food, livestock and poultry feed. Besides this, maize has wider applications in milling industries for starch and oil extraction. Its large-scale application lies in biofuel or ethanol production in many developed countries, especially in the USA and Brazil. Maize originated from central Mexico and is currently one of the most widely distributed crops in the world. It is grown in more than 160 countries of the world and the USA, China, Brazil, Mexico, France and India are the major producers. At the beginning of the 17$^{th}$ century, it was introduced into India from Central America.

In India, maize is cultivated at 9.83 million hectares with a production of 26.26 million tonnes and productivity of 2664 kg/ha. India stands sixth in the world for maize production. Cultivation of maize in India is mostly confined to the states of Rajasthan, Maharashtra, Gujarat, Uttar Pradesh, Karnataka, Madhya Pradesh, Andhra Pradesh and Jammu-Kashmir. Gujarat occupies an area of 0.45 million hectares with a production of 0.80 million tonnes and productivity of 1780 kg/ha (Anon., 2017) [1]. The important districts of Gujarat growing maize are Dahod, Punchmahal, Vadodara, Samantha, Kheda, Banaskantha, Bharuch, Anand and Dang.

The fall armyworm, Spodoptera frugiperda (J.E. Smith) (Lepidoptera: Noctuidae) is native to America and it is a key pest of maize and many other crops throughout America. S. frugiperda was reported for the first time in 2016 in Africa, causing significant damage to maize. This pest was detected for the first time on the Indian subcontinent in mid-May, 2018 in maize fields at the College of Agriculture, (UAHS), Shivamogga. Similar information has also just been released on independent investigations by the National Bureau of Agriculturally Important Microorganisms (NBAIR) under the Indian Council of Agricultural Research (ICAR).

The damage caused by *S. frugiperda* during early and cob formation is the most concern and farmers everywhere feel the need to protect such high-value crops from any damage caused by insect pests. They often use synthetic insecticides indiscriminately and insects develop resistance to insecticides is very common in the tropics. So, for the management of this pest efficiently, some pesticides with novel modes of action have been developed recently. These pesticides with novel modes of action and high selectivity are highly effective against *S. frugiperda*. The effectiveness of these novel insecticides can be evaluated in the laboratory as well as in field conditions for their effectiveness against this new invasive pest. The important constraint in the effective utilization of these molecules is the lack of persistence infield, which is essential to study in maize crops.

## Material and Methodology

### Methodology

Experiment was conducted at Biocontrol Research Laboratory, Department of Entomology, College of Agriculture, JAU, Junagadh during *kharif* 2020 with following treatments. The culture of *S. frugiperda* was maintained at Biocontrol Research Laboratory, Department of Entomology and first-generation larvae were used in this experiment. Fresh maize leaves collected from the unsprayed maize field were washed properly with clean water and air-dried. The spray of each treatment was applied to maize leaves separately with the help of an atomizer or hand sprayer. Care was taken to obtain uniform coverage of insecticide on the leaves. Treated leaves were allowed to dry under a ceiling fan for 15 minutes. The one-day starved third instar larvae of *S. frugiperda* were kept individually in plastic boxes (7.5 cm × 3.9 cm) along with lips made of small holes for ventilation. Then the treated leaves were provided as food for them. Ten larvae per treatment in each repetition were kept. The larvae were provided with fresh untreated food after 24 hours of feeding on the treated food.

Treatments details

| Sr. No. | Treatment | Conc. (%) | Qty. of form. in g or ml/10 lit water | g a.i./ha | Qty of formulation kg or lit./ha |
|---|---|---|---|---|---|
| $T_1$ | Thiodicarb 75% WP | 0.075 | 10 | 375 | 0.5 kg. |
| $T_2$ | Spinosad 45% SC | 0.013 | 3 | 68 | 0.150 lit. |
| $T_3$ | Chlorantraniliprole 18.5% SC | 0.005 | 3 | 28 | 0.150 lit. |
| $T_4$ | Spinetoram 11.7% EC | 0.012 | 10 | 59 | 0.5 lit. |
| $T_5$ | Emamectin benzoate 5% SG | 0.0025 | 5 | 13 | 0.250 g. |
| $T_6$ | Novaluron 10% EC | 0.010 | 10 | 50 | 0.5 lit. |
| $T_7$ | Chlorantraniliprole 9.3% + Lambda-cyhalothrin 4.6% ZC | 0.006 | 4 | 28 | 0.200 lit. |
| $T_8$ | Profenophos 40% + Cypermethrin 4% | 0.044 | 10 | 220 | 0.5 lit. |
| $T_9$ | Control (Water spray) | - | - | - | - |

### Methods of recording observations

Mortality counts were recorded at 1, 3, 5 and 7 days after the treatment. Data on larval mortality was converted into corrected per cent mortality. This was calculated by using the following modified formula given by Henderson and Tilton (1955) [8].

Corrected per cent mortality = $100 \times [1 - \{(T_a \times C_b)/(T_b \times C_a)\}]$

Where,

$T_b$= Number of *S. frugiperda* larvae counted before treatment

$T_a$= Number of *S. frugiperda* larvae counted after treatment

$C_{b=}$ Number of *S. frugiperda* larvae counted from untreated control plot before treatment

$C_a$=Number of *S. frugiperda* larvae counted from untreated control plot after treatment

The zero and cent per cent value was removed by using the formula (1/4n)×100 and [1-(1/4n)]×100, respectively (Bartlet, 1947; Gomez and Gomez, 1984) [2, 5] where 'n' is the number of larvae per treatment. The data thus obtained was transformed and then it was analyzed statistically (Bartlet, 1947) [2].

## Results and Discussion

The bio-efficacy of different chemical insecticides against *S. frugiperda* was tested under laboratory conditions. The mortality recorded at 1, 3 and 5 days after the application of treatments is presented in Table 1. The results revealed that there was a significant difference in per cent larval mortality on every day of observations. All the treatments were found significantly superior by giving higher mortality of larva over the control.

After 1 day, the treatment of spinetoram 11.7 EC, 0.012% was found superior among all the treatments, which gave 83.33% mortality and it was followed by emamectin benzoate 5 SG, 0.0025% (74.44%) and thiodicarb 75 WP, 0.075% (66.67%). The treatments of chlorantraniliprole 18.5 SC, 0.005% (61.11%), spinosad 45 SC, 0.013% (56.67%) and chlorantraniliprole 9.3% + lambda-cyhalothrin 4.6% ZC, 0.006% (51.11%) were found next effective in mortality. The remaining treatments provided poor results having less than 50 per cent mortality.

Data recorded at 3 days after treatment indicated that spinetoram 11.7 EC, 0.012% gave cent per cent mortality. The treatments of emamectin benzoate 5 SG, 0.0025% and thiodicarb 75 WP, 0.075% were found next better treatments in which larval mortality of 93.33 and 90.00%, respectively was recorded.

**Table 1:** Bio-efficacy of different insecticides against fall armyworm, *S. frugiperda* infesting maize under laboratory condition

| Sr. No. | Treatments | Per cent mortality (%) | | |
|---|---|---|---|---|
| | | 1 DAF | 3 DAF | 5 DAF |
| $T_1$ | Thiodicarb 75 WP, 0.075% | 54.74 (66.67) | 71.57 (90.00) | 80.90 (97.50) |
| $T_2$ | Spinosad 45 SC, 0.013% | 48.84 (56.67) | 56.81 (70.00) | 64.26 (81.11) |
| $T_3$ | Chlorantraniliprole 18.5 SC, 0.005% | 51.45 (61.11) | 59.67 (74.44) | 67.69 (85.56) |
| $T_4$ | Spinetoram 11.7 EC, 0.012% | 65.91 (83.33) | 80.90 (97.50) | 80.90 (97.50) |
| $T_5$ | Emamectin benzoate 5 SG, 0.0025% | 59.64 (74.44) | 75.04 (93.33) | 80.90 (97.50) |
| $T_6$ | Novaluron 10 EC, 0.010% | 37.25 (36.67) | 48.84 (56.67) | 52.84 (63.33) |
| $T_7$ | Chlorantraniliprole 9.3% +Lambda-cyhalothrin 4.6% ZC, 0.006% | 45.64 (51.11) | 52.75 (63.33) | 56.88 (70.00) |
| $T_8$ | Profenophos 40% + Cypermethrin 4%, 0.044% | 31.06 (26.67) | 39.16 (40.00) | 42.45 (45.56) |
| $T_9$ | Control (Water spray) | 13.48 (5.56) | 18.83 (11.11) | 24.92 (7.78) |
| S.Em.± | | 1.07 | 1.83 | 1.41 |
| C.D. at 5% | | 3.17 | 5.44 | 4.20 |
| C.V. % | | 4.08 | 5.67 | 3.99 |

*Figures in parenthesis are original values, while outsides are arcsine transformed values. DAF –Days After Feeding.

The treatments of chlorantraniliprole 18.5 SC, 0.005%, spinosad 45 SC, 0.013% and chlorantraniliprole 9.3% + lambda-cyhalothrin 4.6% ZC, 0.006% were found moderately effective with 74.44, 70.00 and 63.33% larval mortality, respectively. The remaining treatments were comparatively less effective as they gave lower mortality.

A perusal of results (Table 1) on mortality of *S. frugiperda* larvae after 5 days of treatment revealed that the treatments of spinetoram 11.7 EC, 0.012%, emamectin benzoate 5 SG, 0.0025% and thiodicarb 75 WP, 0.075% gave the cent per cent mortality of *S. frugiperda* larvae. However, the remaining treatments, chlorantraniliprole 18.5 SC, 0.005%, spinosad 45 SC, 0.013% and chlorantraniliprole 9.3% +lambda-cyhalothrin 4.6% ZC, 0.006% were found next in order in which mortality of 85.56, 81.11 and 70.00%, respectively was recorded.

The overall results showed that the treatments of spinetoram 11.7 EC, 0.012%, emamectin benzoate 5 SG, 0.0025% and thiodicarb 75 WP, 0.075% were found the most toxic against *S. frugiperda*. The present findings are in conformation with Mallapur *et al*. (2019) [6], who observed that spinetoram 11.7 EC and emamectin benzoate 5 SG were significantly superior over all other treatments with the larval reduction of 98.13 and 96.26%, respectively at 7 days after treatment imposition. A similar trend was also observed by Bonni *et al.* (2020) [3], who recorded higher mortality rates in the laboratory with emamectin benzoate (94.16±2.6%) and spinetoram (79.16±4.91%) against *S. frugiperda*. According to Deshmukh *et al.* (2020) [4], emamectin benzoate 5 SG showed the highest acute toxicity, followed by chlorantraniliprole 18.5 SC and spinetoram 11.7 SC against *S. frugiperda*. This result is in line with our findings in which all these insecticides were found effective for the mortality of larvae. The present results are also in conformity with the work of Shareef *et al.* (2022) [7], who reported that emamectin benzoate 5 SG was found most toxic against *S. frugiperda* followed by spinetoram 11.7 SC. Thus, the present findings are more or less in agreement with the results reported by earlier workers, slight variations may be due to climatic conditions.

## Conclusion

The treatments of spinetoram 11.7 EC, 0.012%, emamectin benzoate 5 SG, 0.0025% and thiodicarb 75 WP, 0.075% were found the most effective against *S. frugiperda* as they recorded cent per cent mortality after 5 days of treatment under laboratory condition. However, it was followed by chlorantraniliprole 18.5 SC, 0.005%, spinosad 45 SC, 0.013% and chlorantraniliprole 9.3% +lambda-cyhalothrin 4.6% ZC, 0.006%. The study concluded that, spinetoram 11.7 EC, emamectin benzoate 5 SG and thiodicarb 75 WP was found the most effective insecticides against *S. frugiperda* under laboratory condition.

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